

CLAIMS:

1. A capacitive plasma enhanced chemical vapor deposition reactor comprising:

a processing chamber;

a susceptor electrode within the chamber configured to support at least one semiconductor workpiece;

a shower head electrode within the chamber operably adjacent the susceptor electrode and configured to provide gaseous reactants into the chamber;

a single RF power generator operatively coupled with the susceptor electrode and the shower head electrode and configured to provide RF power thereto effective to develop a plasma processing environment within the chamber and a desired bias relative to the semiconductor workpiece; and

an RF power splitter operatively interposed the RF power generator and both the susceptor electrode and the shower head electrode, the RF power splitter configured to provide power from the RF power generator to both the susceptor and the shower head at a selected power ratio between the susceptor electrode and the shower head electrode.

1 2. The plasma enhanced chemical vapor deposition reactor of
2 claim 1, wherein the susceptor electrode and the shower head electrode
3 have respective surface areas which are different from one another, and
4 the selected power ratio is proportional to a surface area ratio
5 therebetween.

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7 3. The plasma enhanced chemical vapor deposition reactor of
8 claim 1, wherein the selected power ratio is other than a 1:1 ratio.

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10 4. The plasma enhanced chemical vapor deposition reactor of
11 claim 1, wherein the RF power splitter comprises a center tapped
12 transformer having at least two output terminals, individual output
13 terminals being connected to a respective one of the susceptor electrode
14 and the shower head electrode.

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16 5. The plasma enhanced chemical vapor deposition reactor of
17 claim 1, wherein:

18 the RF power splitter comprises a center tapped transformer;

19 the susceptor electrode and the shower head electrode have
20 respective surface areas which are different from one another; and

21 the selected power ratio is proportional to a surface area ratio
22 therebetween.

1 6. The plasma enhanced chemical vapor deposition reactor of
2 claim 1, wherein the susceptor electrode and the shower head electrode
3 have respective surface areas which are substantially equivalent.

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5 7. The plasma enhanced chemical vapor deposition reactor of
6 claim 1, wherein the selected power ratio is adjustable.

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8 8. The plasma enhanced chemical vapor deposition reactor of
9 claim 1, wherein the RF power splitter comprises a transformer having
10 a plurality of variably groundable windings for changing the selected
11 power ratio.

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13 9. The plasma enhanced chemical vapor deposition reactor of
14 claim 1, wherein the susceptor electrode and the shower head electrode
15 have respective surface areas which are substantially equivalent, and the
16 selected power ratio is adjustable.

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18 10. The plasma enhanced chemical vapor deposition reactor of
19 claim 1, wherein the susceptor electrode and the shower head electrode
20 have respective surface areas which are substantially equivalent, and the
21 RF power splitter comprises a transformer having a plurality of variably
22 groundable windings for adjusting the selected power ratio.

1 11. A plasma enhanced chemical vapor deposition reactor
2 comprising:

3 a chamber defining a processing volume;

4 a first electrode operably associated with the chamber;

5 a second electrode operably associated with the chamber;

6 a single RF power generator; and

7 a transformer having an input side and an output side, the input
8 side being connected to the RF power generator for receiving power
9 generated thereby, and the output side having no more than two output
10 terminals, one output terminal being connected to the first electrode,
11 and the other output terminal being connected to the second electrode,
12 the output side providing power to each of the first and second
13 electrodes in accordance with a selected power ratio.
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15 12. The plasma enhanced chemical vapor deposition reactor of
16 claim 11, wherein at least one of the electrodes is disposed inside the
17 chamber and is configured for supporting a semiconductor workpiece.
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19 13. The plasma enhanced chemical vapor deposition reactor of
20 claim 11, wherein one of the electrodes is disposed outside the
21 chamber.
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1 14. The plasma enhanced chemical vapor deposition reactor of
2 claim 11, wherein both the first and second electrodes are disposed
3 inside the chamber, the first electrode being configured for supporting
4 a semiconductor workpiece.

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6 15. The plasma enhanced chemical vapor deposition reactor of
7 claim 11, wherein the first and second electrodes comprise respective
8 surface areas which are different from one another.

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10 16. The plasma enhanced chemical vapor deposition reactor of
11 claim 11, wherein:

12 both the first and second electrodes are disposed inside the
13 chamber, the first electrode being configured for supporting a
14 semiconductor workpiece; and

15 the first and second electrodes comprise respective surface areas
16 which are different from one another.

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18 17. The plasma enhanced chemical vapor deposition reactor of
19 claim 11, wherein the transformer output side comprises a plurality of
20 variably groundable windings for varying the selected power ratio.

1 18. A parallel plate plasma enhanced chemical vapor deposition
2 reactor comprising:

3 a processing chamber;

4 a susceptor electrode in the chamber and configured to support
5 at least one semiconductor workpiece, the susceptor electrode comprising
6 a first surface area;

7 a shower head electrode in the chamber and configured to provide
8 reactants into the chamber, the shower head electrode comprising a
9 second surface area which is less than the first surface area; and

10 a single RF power source operatively coupled to both the shower
11 head electrode and the susceptor electrode and configured to provide
12 RF power to each electrode according to a predefined relative
13 magnitude effective to develop a desired bias relative to a
14 semiconductor workpiece supported by the susceptor electrode and to
15 develop a plasma processing environment within the processing chamber.

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17 19. The parallel plate plasma enhanced chemical vapor
18 deposition reactor of claim 18, wherein the predefined relative
19 magnitude is directly proportional to the inverse ratio of the 4th power
20 of the areas of the electrodes.

1 20. A parallel plate plasma enhanced chemical vapor deposition
2 reactor comprising:

3 a processing chamber;

4 a susceptor electrode within the chamber configured to support at
5 least one semiconductor workpiece, the susceptor electrode having a
6 susceptor surface area;

7 a shower head electrode within the chamber operably adjacent the
8 susceptor electrode and configured to provide gaseous reactants into the
9 chamber, the shower head electrode having a shower head surface area
10 which is smaller than the susceptor electrode surface area;

11 a single RF power generator operatively associated with the
12 processing chamber and configured to provide RF power;

13 a center tapped transformer having an input side and no more
14 than two output terminals, the input side being operably connected with
15 and capable of receiving RF power from the RF power generator, and
16 individual respective output terminals being connected with the susceptor
17 electrode and the shower head electrode and configured to provide RF
18 power to each electrode at a selected power ratio which is proportional
19 to a ratio of the areas of the electrodes.

1 21. A plasma enhanced chemical vapor deposition reactor
2 comprising:

3 a processing chamber;

4 a first electrode inside the chamber and configured for supporting
5 a workpiece;

6 a second electrode operably associated with the chamber;

7 a single RF power generator configured to provide RF power;

8 a transformer having an input side and an output side with only
9 two output terminals which form individual connections with any of the
10 reactor's electrodes, the input side being operably connected with and
11 receiving power from the RF power generator, the output terminals
12 being configured to provide RF power to each electrode at a selected
13 power ratio which is effective to both (a) develop a desired bias
14 relative to a workpiece, and (b) establish and maintain a plasma
15 processing environment inside the processing chamber; and

16 the output side further comprising a plurality of windings
17 individual windings of which can be selectively grounded for varying the
18 RF power provided to the respective electrodes and the selected power
19 ratio thereof.

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21 22. The plasma enhanced chemical vapor deposition reactor of
22 claim 21, wherein the reactor is an inductive coil reactor and the
23 second electrode is disposed outside the chamber.
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1 23. The plasma enhanced chemical vapor deposition reactor of
2 claim 21, wherein the reactor is a parallel plate reactor and the second
3 electrode is disposed inside the chamber.

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5 24. A semiconductor processing method of plasma enhanced
6 chemical vapor depositing material over a semiconductor workpiece
7 within a processing chamber comprising:

8 providing a first electrode for supporting a workpiece;

9 providing a second electrode operably associated with the chamber,
10 the first and second electrodes constituting the only processing chamber
11 electrodes relative to which a desired bias is to be developed and a
12 plasma processing environment is to be created;

13 applying RF power to both the first and second electrodes from
14 a single RF power generator, the applied power defining a selected
15 power ratio between the first and second electrodes which is other than
16 a 1:1 ratio; and

17 providing at least one reactive gas within the processing chamber
18 effective to chemical vapor deposit a layer of material on a wafer
19 supported by the first electrode within the processing chamber.

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21 25. The semiconductor processing method of claim 24, wherein
22 the second electrode is provided inside the chamber.

1 26. The semiconductor processing method of claim 24, wherein
2 the second electrode is provided outside the chamber.

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4 27. The semiconductor processing method of claim 24, wherein:
5 the second electrode is provided inside the chamber;

6 the first electrode comprises a susceptor electrode having a
7 defined surface area;

8 the second electrode comprises a shower head electrode having a
9 defined surface area, the shower head electrode being configured to
10 provide reactants into the chamber; and

11 the respective surface areas of the first and second electrodes are
12 different from one another.

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14 28. The semiconductor processing method of claim 24, wherein
15 the applying step comprises:

16 forming an operative connection between the first electrode, the
17 second electrode, and an RF power splitter;

18 forming an operative connection between the RF power splitter
19 and the single RF power generator;

20 splitting RF power supplied by the RF power generator into first
21 and second power components;

22 applying the first power component to the first electrode; and

23 applying the second power component to the second electrode.
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1 29. The semiconductor processing method of claim 24, wherein
2 the applying step comprises:

3 forming an operative connection between the first electrode, the
4 second electrode, and a transformer having an input side and an output
5 side, the first and second electrodes being operatively coupled with the
6 transformer output side;

7 forming an operative connection between the transformer input
8 side and the single RF power generator;

9 splitting RF power supplied by the RF power generator into first
10 and second power components;

11 applying the first power component to the first electrode; and

12 applying the second power component to the second electrode.
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1 30. The semiconductor processing method of claim 24, wherein
2 the applying step comprises:

3 forming an operative connection between the first electrode, the
4 second electrode, and a transformer having an input side and an output
5 side, the first and second electrodes being operatively coupled with the
6 transformer output side;

7 forming an operative connection between the transformer input
8 side and the single RF power generator;

9 splitting RF power supplied by the RF power generator into first
10 and second power components;

11 applying the first power component to the first electrode;

12 applying the second power component to the second electrode;

13 and

14 wherein the transformer output side comprises a plurality of
15 variably groundable coils for enabling the respective magnitudes of the
16 first and second power components to be varied.

1 31. A semiconductor processing method of plasma enhanced
2 chemical vapor depositing material over a semiconductor workpiece
3 within a processing chamber comprising:

4 providing a first electrode inside the chamber for supporting a
5 workpiece;

6 providing a second electrode inside the chamber;

7 providing a transformer having an input side and an output side,
8 the output side comprising a plurality of coils, one of the coils
9 comprising a center coil;

10 forming an operative connection between the transformer input
11 side and a single RF power generator, the generator being configured
12 to provide RF power to the transformer input side and comprising the
13 only RF power source which is operably associated with the processing
14 chamber;

15 forming an operative connection between the transformer output
16 side and the first and second electrodes, said connection comprising the
17 only connection between the transformer and any processing chamber
18 electrode;

19 grounding one of the transformer output side coils other than the
20 center coil to produce first and second power components which are
21 different in magnitude from one another, the first power component
22 being applied to the first electrode and the second power component
23 being applied to the second electrode; and
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1 providing at least one reactive gas within the processing chamber
2 effective to chemical vapor deposit a layer of material on a wafer
3 supported by the first electrode within the processing chamber.
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5 32. The semiconductor processing method of claim 31, wherein
6 the first power component is greater than the second power component.

7 33. The semiconductor processing method of claim 31, wherein
8 the transformer is capable of having others of the plurality of output
9 side coils selectively grounded for varying the relative magnitudes of the
10 first and second power components.
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1 34. A semiconductor processing method of chemical vapor
2 depositing material over a semiconductor workpiece within a processing
3 chamber comprising:

4 splitting RF power produced by a single RF power source into
5 first and second RF power components of different magnitudes, the
6 single RF power source comprising the only RF power source which is
7 associated with the processing chamber;

8 powering only two processing chamber electrodes with the
9 respective different magnitude first and second RF power components;
10 and

11 providing at least one reactive gas within the processing chamber
12 effective to chemical vapor deposit a layer of material on a wafer
13 supported by one of the electrodes within the processing chamber.

14
15 35. The semiconductor processing method of claim 34, wherein
16 the powering comprises:

17 powering a first electrode with the first RF power component, the
18 first electrode supporting at least one semiconductor workpiece for
19 processing; and

20 powering a second electrode with the second RF power
21 component, the second electrode being powered to a greater magnitude
22 than the first electrode.
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1 36. The semiconductor processing method of claim 34, wherein
2 at least one of the processing chamber electrodes is disposed on the
3 exterior of the processing chamber.

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5 37. A semiconductor processing method of effecting plasma
6 enhanced chemical vapor deposition comprising applying RF power to
7 only two electrodes comprising part of a plasma enhanced chemical
8 vapor deposition reactor from a single RF power generator during
9 deposition, the single RF power generator comprising the only RF
10 power generator which is associated with the reactor.

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12 38. The semiconductor processing method of claim 37, wherein
13 the electrodes are disposed interiorly of the reactor and have respective
14 surface areas which are different from one another.

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16 39. The semiconductor processing method of claim 37, wherein
17 at least one of the electrodes is disposed interiorly of the reactor.

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19 40. The semiconductor processing method of claim 37, wherein
20 the reactor is an inductive coil reactor.

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22 41. The semiconductor processing method of claim 37, wherein
23 the RF power is applied to the electrodes according to a selected
24 power ratio other than 1:1.